

# Z(ee)+Jets Analysis

---

→ Data & MC Tuning



Marc Buehler

H(Multileptons)

11-18-04

1

# Samples

---

- **Data:**
  - EM1TRK skim
  - Single EM triggers
  - Run range: 20 April 2002 - 28 June 2004 (Runs 151,817 - 194,566)
  - Rejecting bad runs (CAL, SMT, CFT, Jet/Met, Lumi)
  - $323\text{pb}^{-1}$
  - No T42 applied
  - Jetcorr v5.1
  - Processed with ATHENA (v01-05-02)
- **MC:**
  - $Z/\text{Gamma}^*$  →  $e^+e^- + X$ : 400k Pythia
  - $Z_j \rightarrow ee j$ : 150k Alpgen + Pythia
  - $Z_j \rightarrow ee jj$ : 180k Alpgen + Pythia
  - $Z_{jj} \rightarrow ee jjj$ : 15k Alpgen + Pythia
  - Processed with ATHENA (v01-05-02)



# Selection Criteria

---

- Removing bad runs/LBNs & dupli events
- PVX cut:  $|z| < 60\text{cm}$
- Using unprescaled single EM triggers
- Electron selection:
  - $|ID|=10,11$
  - $\text{EMF} > 0.9$
  - $\text{Iso} < 0.15$
  - $\text{HMK}(7) < 12$
  - $p_T > 25\text{GeV}$
  - $|\text{det\_eta}| < 1.1$
  - Including phi cracks
- Z selection:
  - $75\text{GeV} < M_{ee} < 105\text{GeV}$
  - At least one trackmatched electron
  - At least one electron needs to fire the trigger
- Jet selection:
  - $0.05 < \text{EMF} < 0.95$
  - $\text{HotF} < 10$
  - $N90 > 1$
  - $\text{CHF} < 0.4$
  - L1conf
  - JES corrected  $p_T > 20\text{GeV}$
  - $|\text{det\_eta}| < 2.5$
  - Removal of jets overlapping with electrons from Z within  $dR$  of 0.4



---

# Z(ee) + X



# Data & MC Tuning: Z(ee)+X

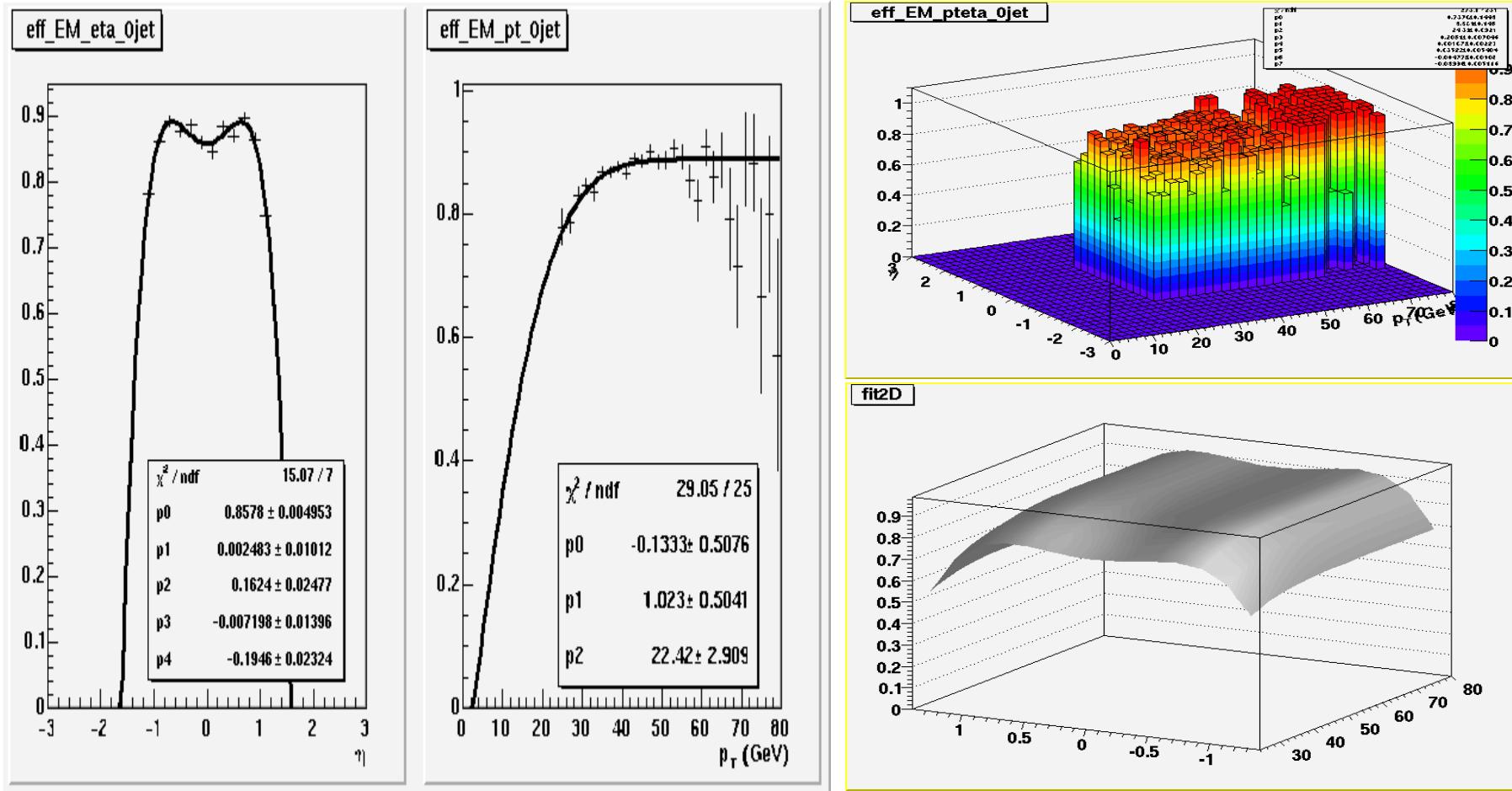
---

	Electrons	Jets
Data	<ul style="list-style-type: none"><li>- Correct for data EM inefficiencies</li><li>- Correct for trigger inefficiencies</li><li>- Correct for data tracking inefficiencies</li><li>- Background subtraction</li></ul>	<ul style="list-style-type: none"><li>- JES 5.1/ JES 5.3</li></ul>
MC	<ul style="list-style-type: none"><li>- Electron smearing</li><li>- Correct for MC EM inefficiencies</li><li>- Correct for MC tracking inefficiencies</li><li>- Correct for difference in Z pT between data and MC</li></ul>	<ul style="list-style-type: none"><li>- JES 5.1/ JES 5.3</li><li>- Jet smearing</li><li>- Jet reco scaling factor</li></ul>



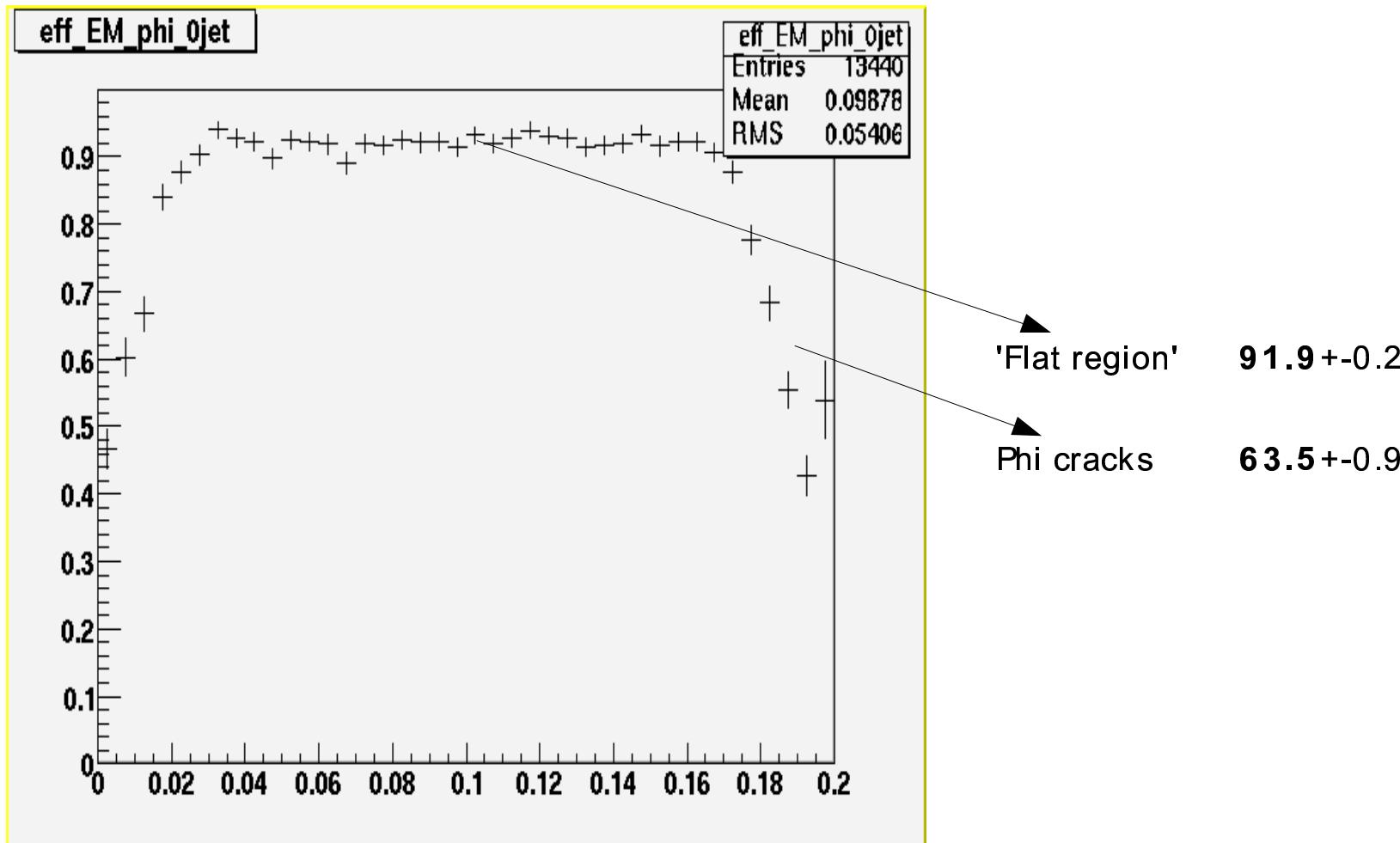
# Z(ee) + X: Data EM inefficiency corrections

- 2D parameterization of EM efficiency vs pT and eta



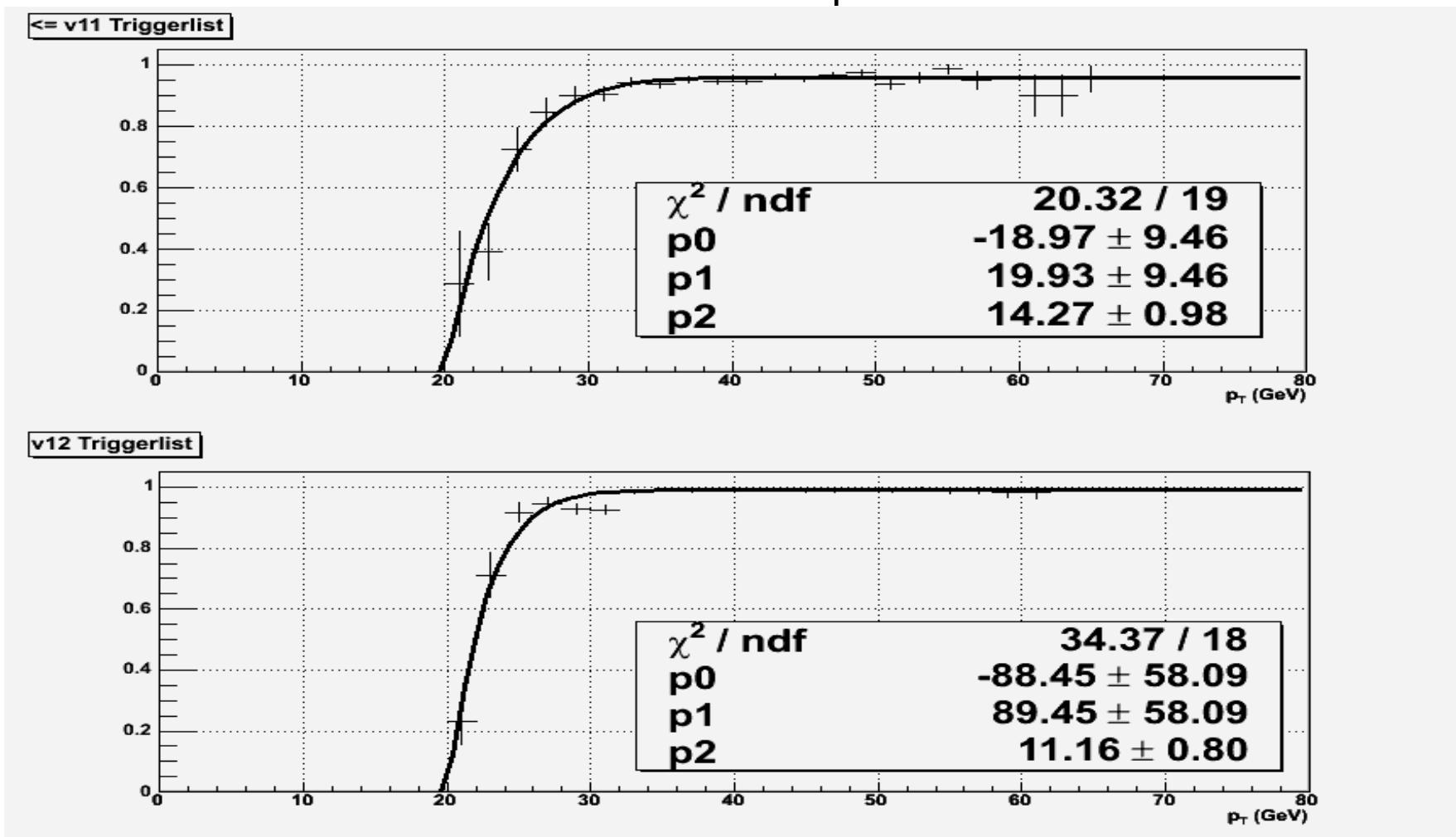
# $Z(\text{ee}) + X$ : Data EM inefficiency corrections

- Factorization of phi dependence



# Z(ee) + X: Data Trigger inefficiency corrections

Parameterized vs pT



# $Z(ee) + X$ : Data Tracking inefficiency corrections

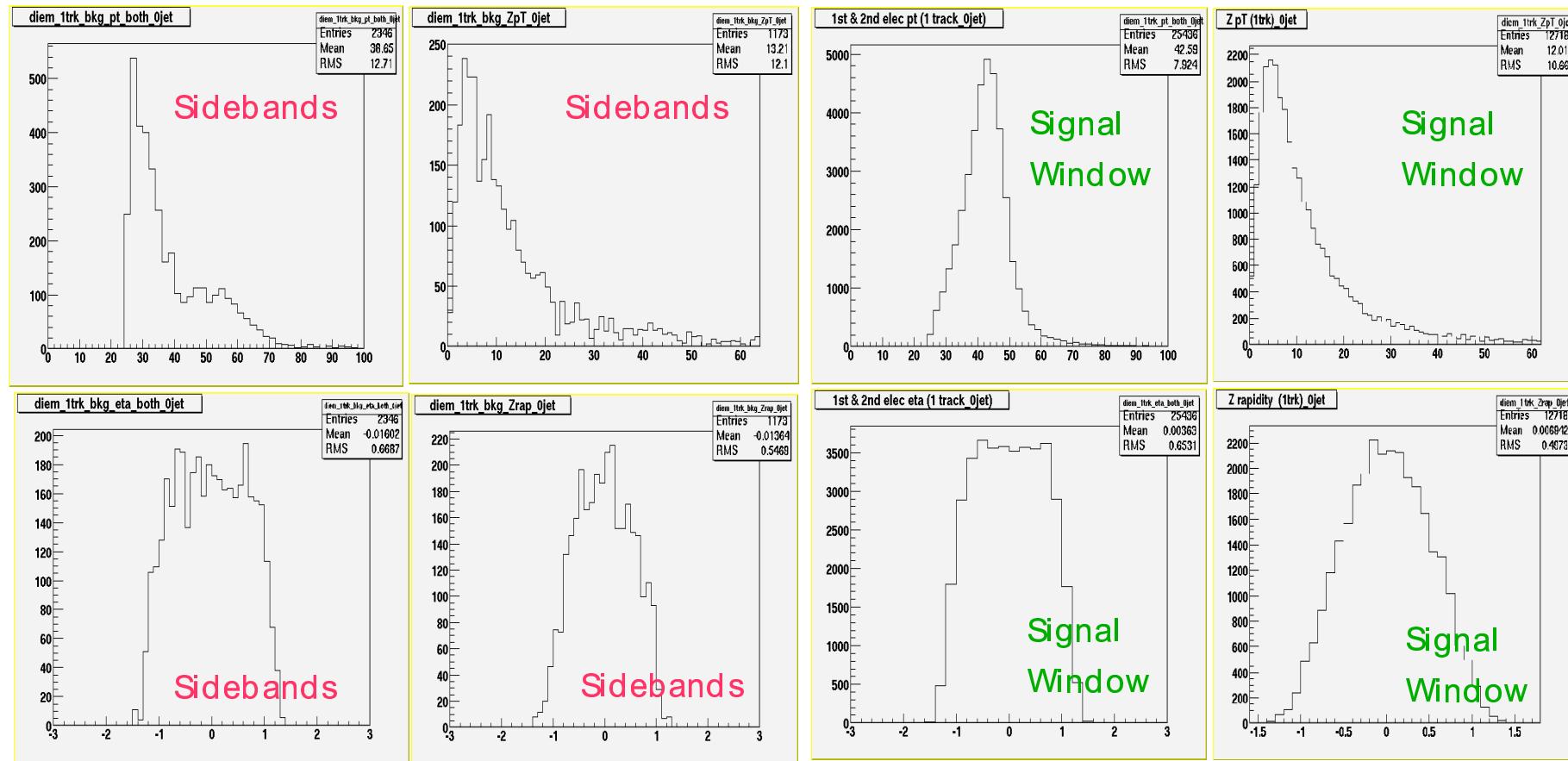
---

- assuming tracking efficiency is flat vs pt, eta, phi
- applying averaged tracking efficiency: ~77%



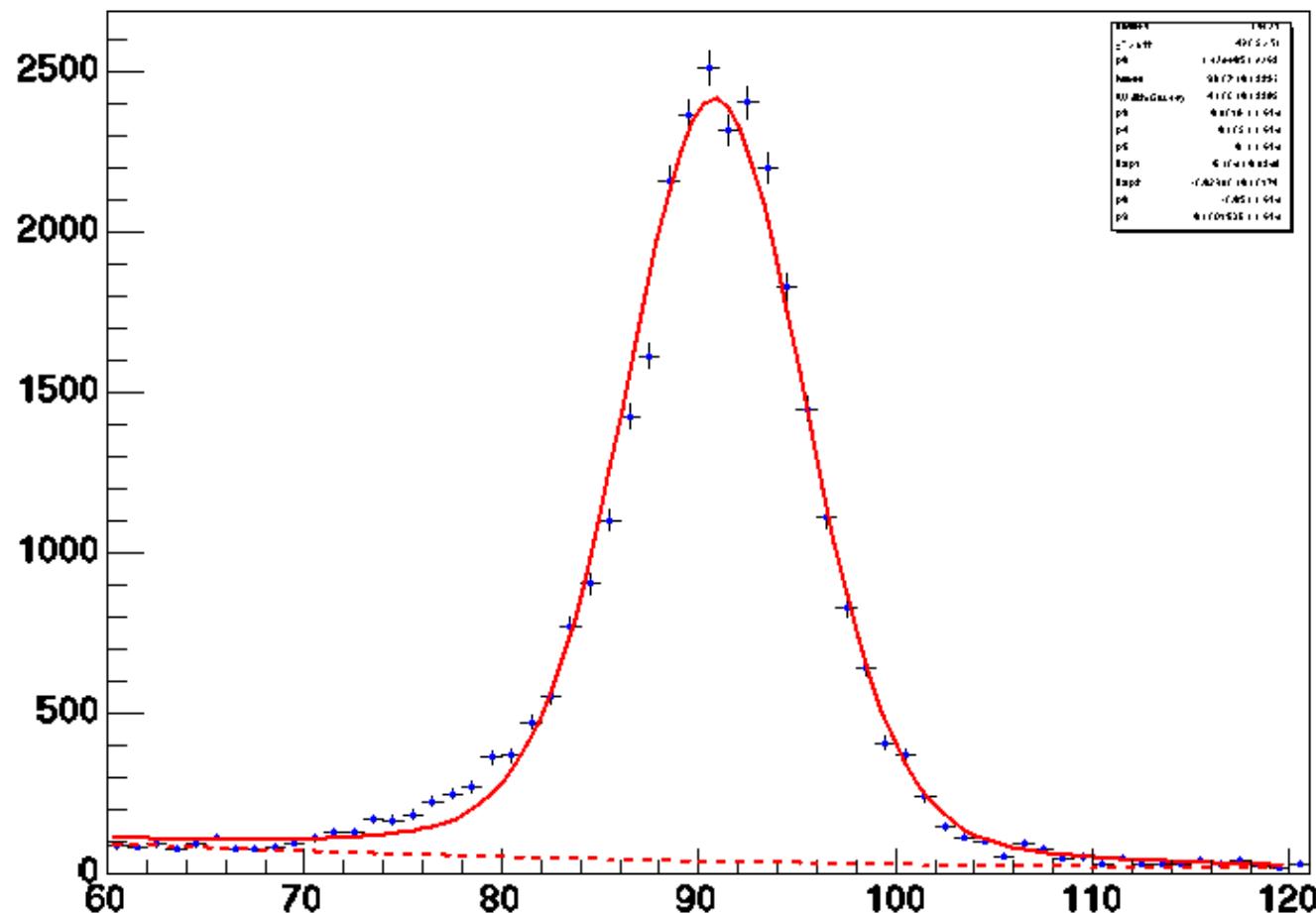
# Z(ee) + X: Data background subtraction

- Gaussian + BW fitting method for Z peak
- Sidebands for electron pT, eta, Z pT, Z rapidity
- Signal window: 75GeV – 105GeV
- Sidebands: 40-75GeV && 105-140GeV



# $Z(ee) + X$ : Data background subtraction

diem invariant mass (1 track,  $\geq 0$  jets)



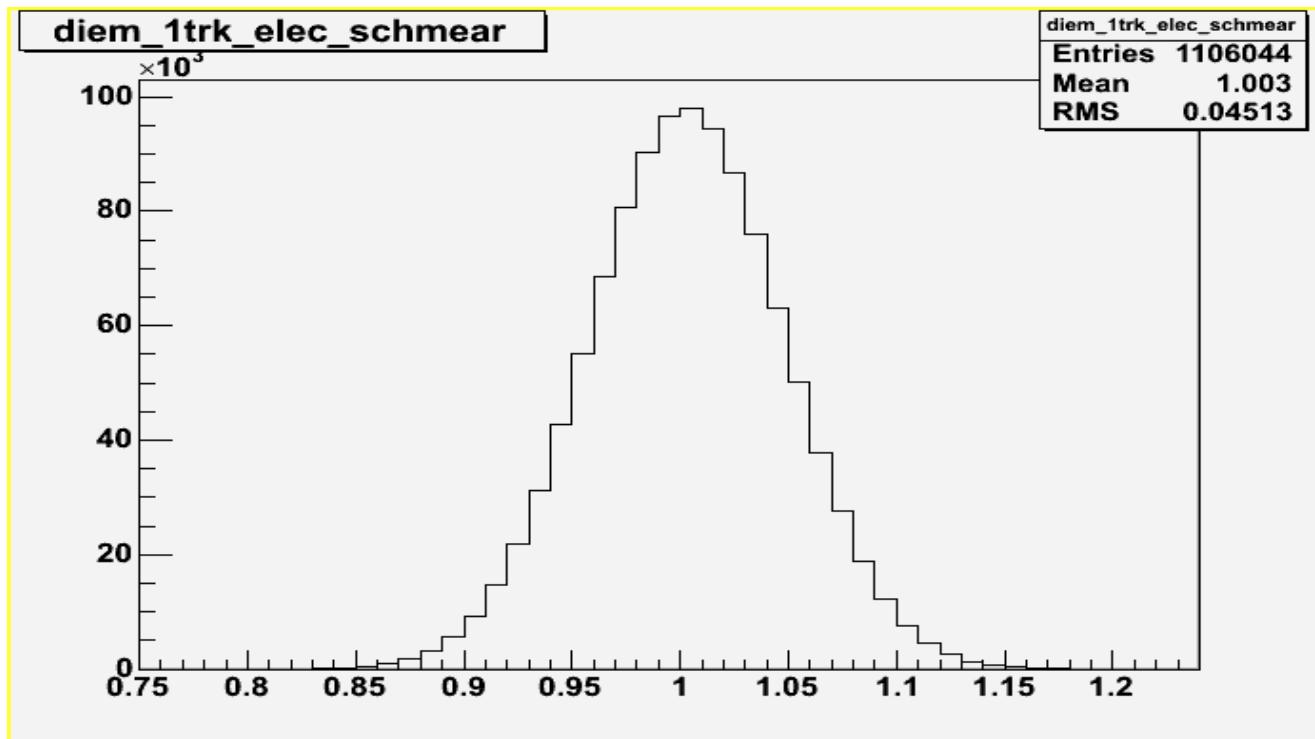
# Z(ee) + X: MC electron smearing

---

Applied to match data and MC pT

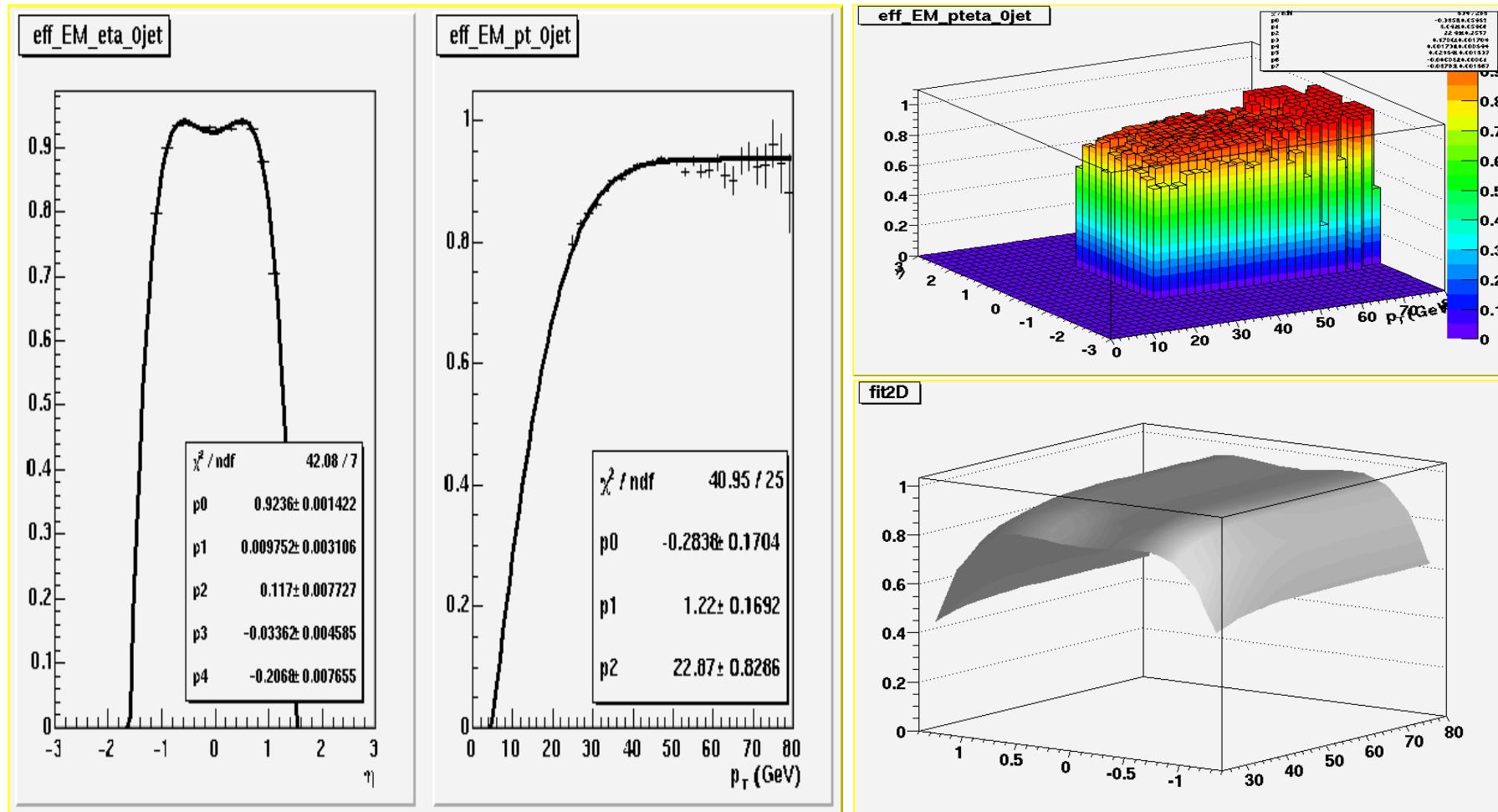
$$pT' = pT c [1 + \text{Gauss}(0, f)] \quad c = 1.003, f = 0.045$$

Same for px, py, pz, E



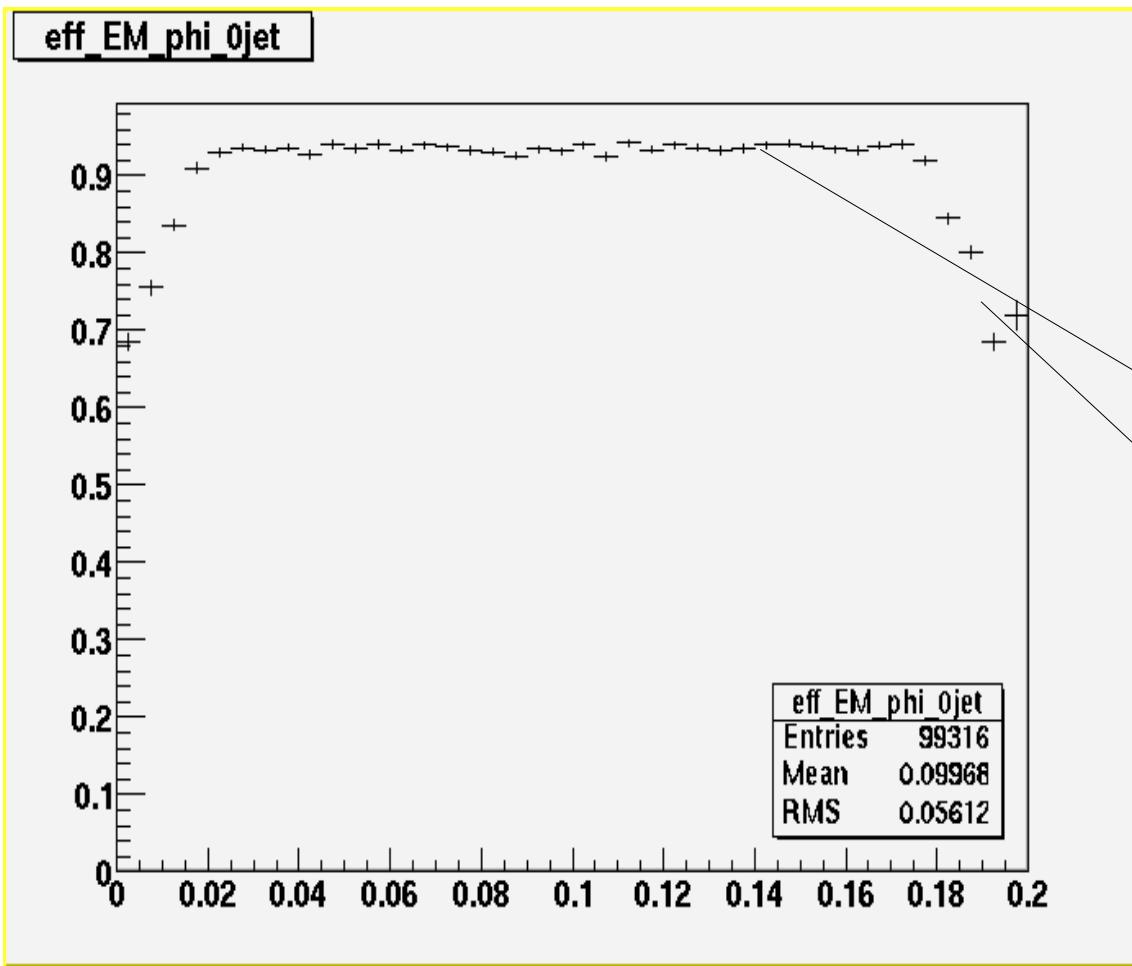
# $Z(ee) + X$ : MC EM inefficiency corrections

- 2D parameterization of EM efficiency vs pT and eta



# $Z(ee) + X$ : MC EM inefficiency corrections

- Factorization of phi dependence



# $Z(ee) + X$ : MC Tracking inefficiency corrections

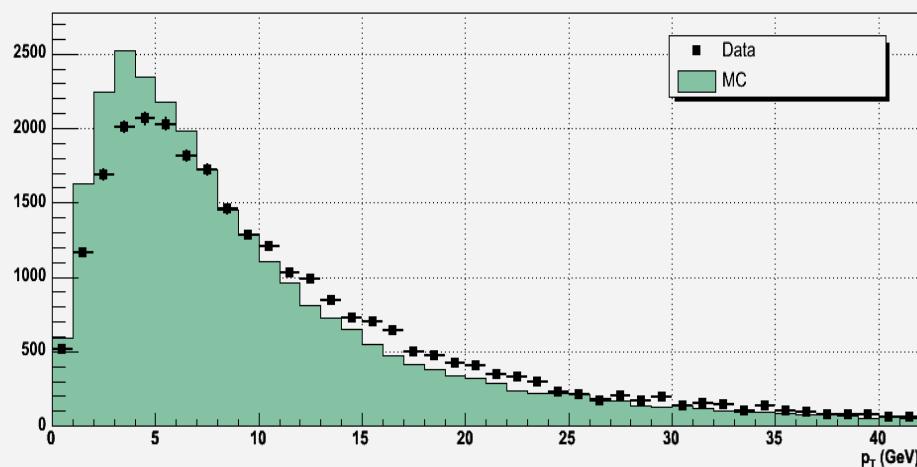
---

- assuming tracking efficiency is flat vs pt, eta, phi
- applying averaged tracking efficiency: ~88%

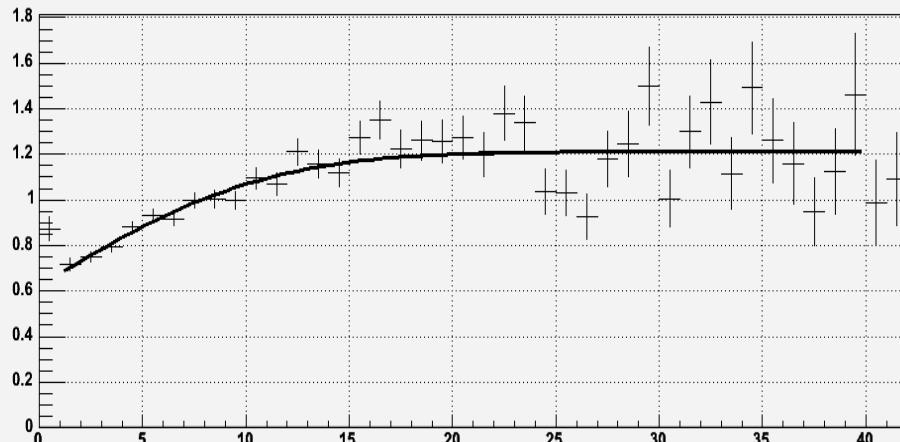


# $Z(\ell\ell) + X$ : Correct for difference in $Z$ pT between data and MC

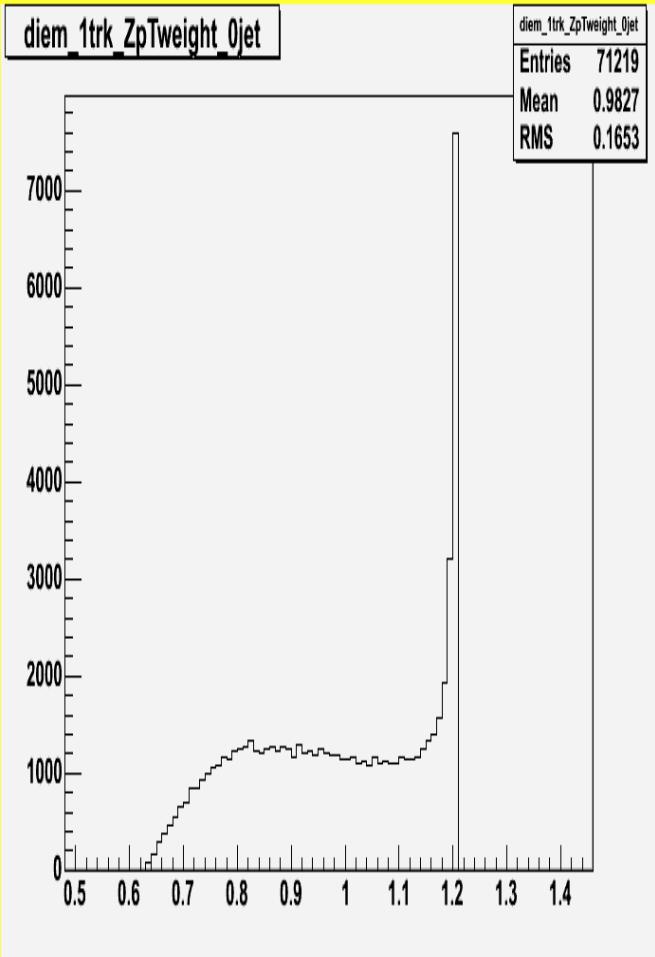
$Z$  pT (1trk)\_0jet



zpt\_ratio



diem\_1trk\_ZpTweight\_0jet



Marc Buehler

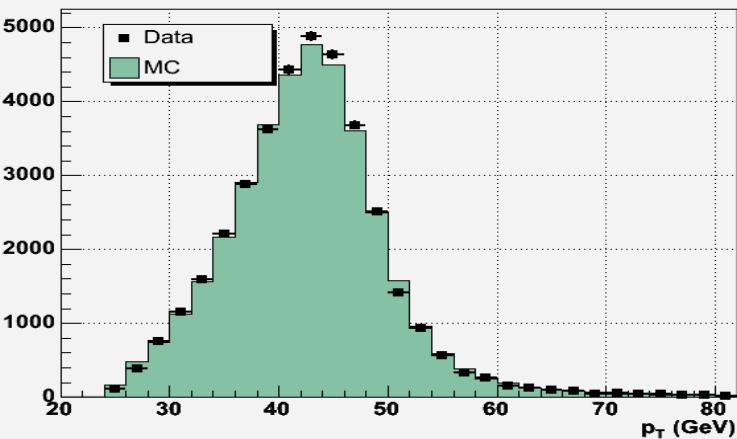
H(Multileptons)

11-18-04

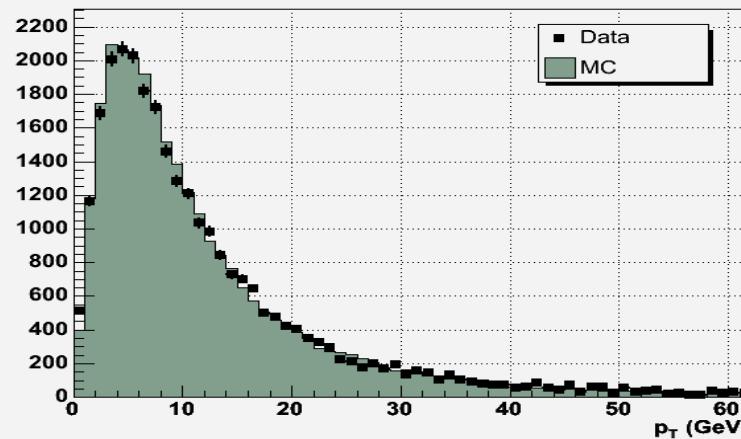
16

# Data vs MC: Z(ee) + X

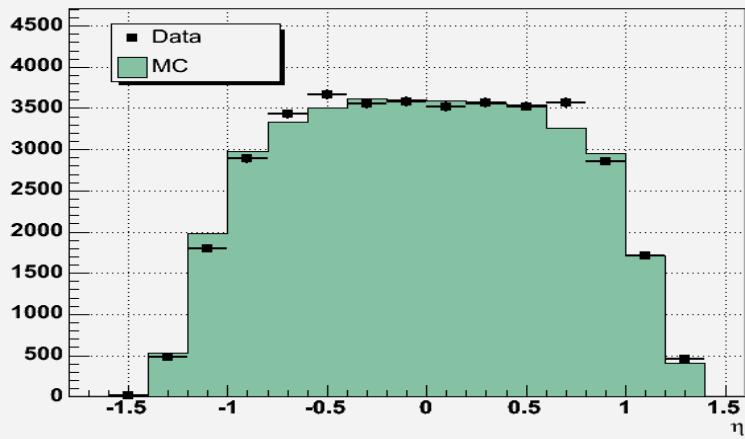
1st & 2nd elec pt (1 track\_0jet)



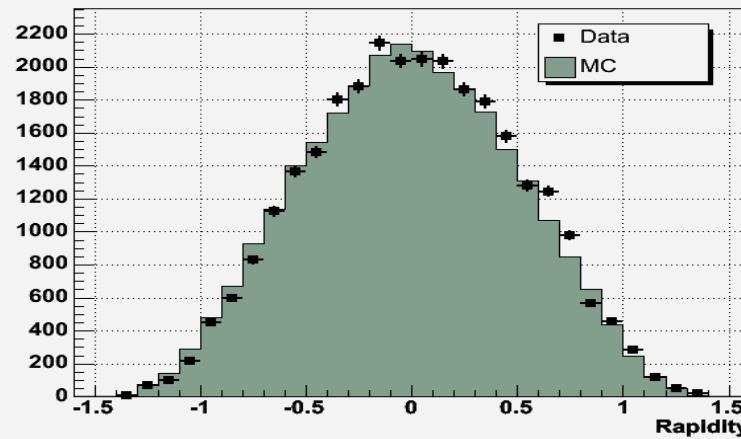
Z pT (1trk)\_0jet



1st & 2nd elec eta (1 track\_0jet)



Z rapidity (1trk)\_0jet

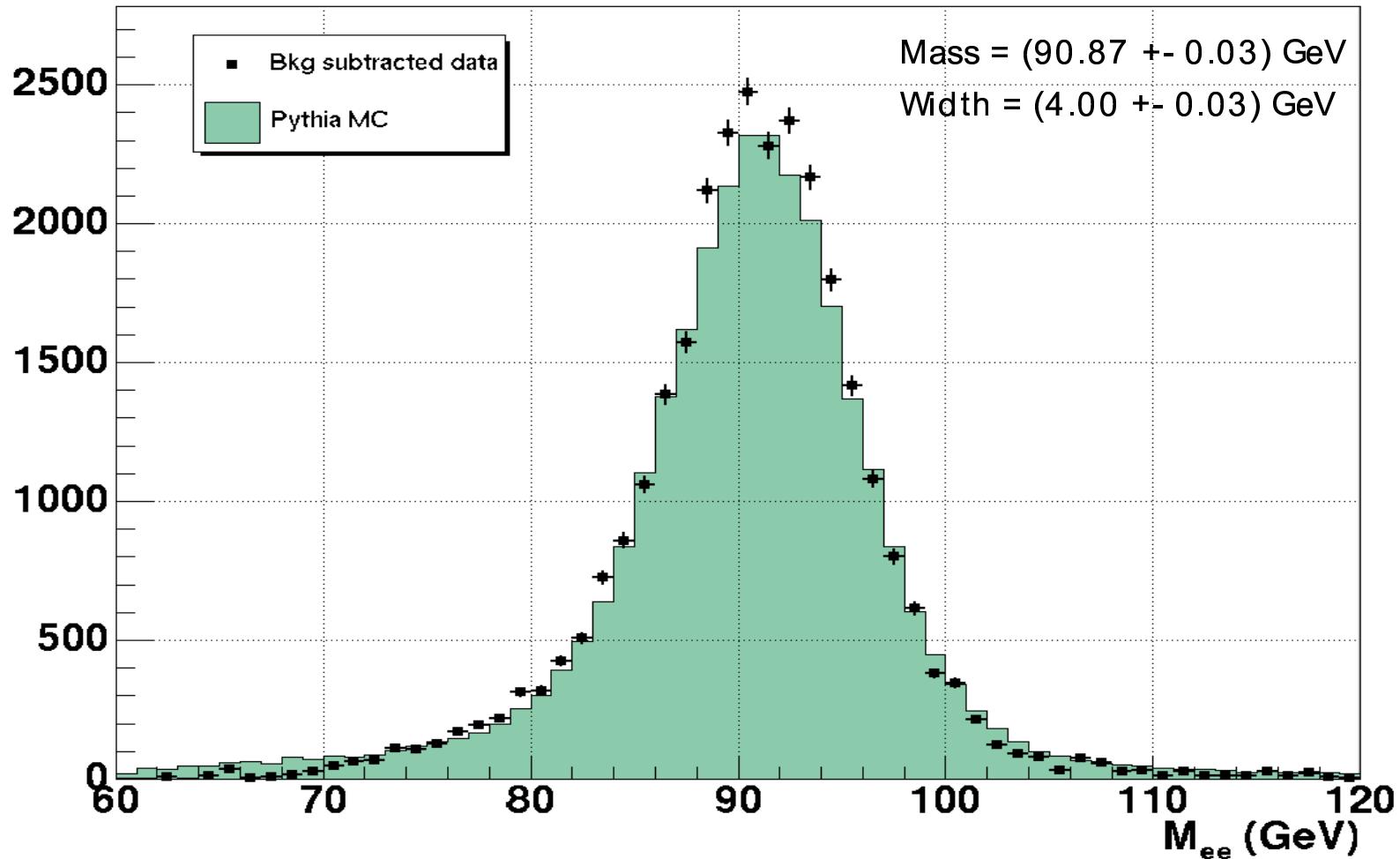


Normalisation is wrt area (shape comparison)



# Data vs MC: $Z(ee) + X$

diem invariant mass (1 track,  $\geq 0$  jets)

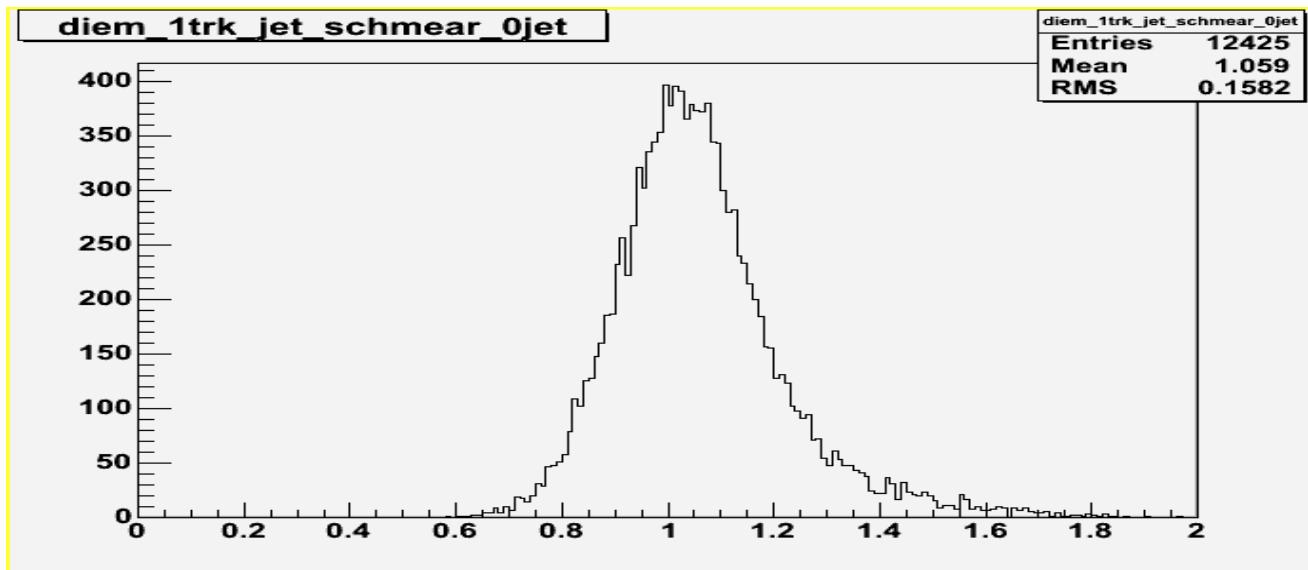


University of Illinois at Chicago

Marc Buehler H(Multileptons) 11-18-04 18

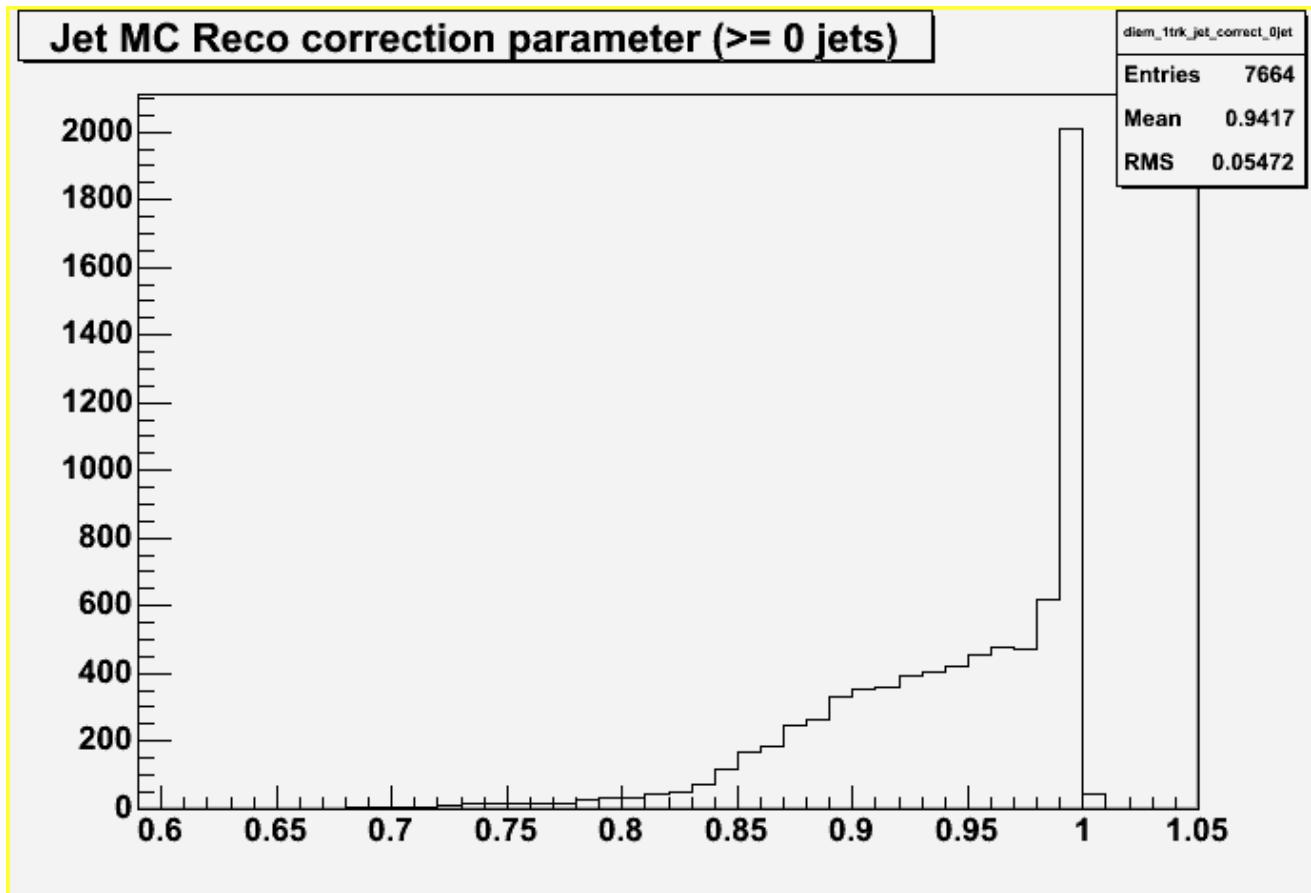
# Z(ee)+X: MC jet smearing

- Need to compensate for different jet energy resolutions in data and MC
- Smearing of MC jets based on JES group parameterization (5.1)
- for a given jet this uses jet pT and det\_eta to calculate the data- and MC-resolution
- if (data\_res < mc\_res) return 1.0
- else: sigma = sqrt( data\_res\*data\_res – mc\_res\*mc\_res )
- return Gaus(1.0, sigma)

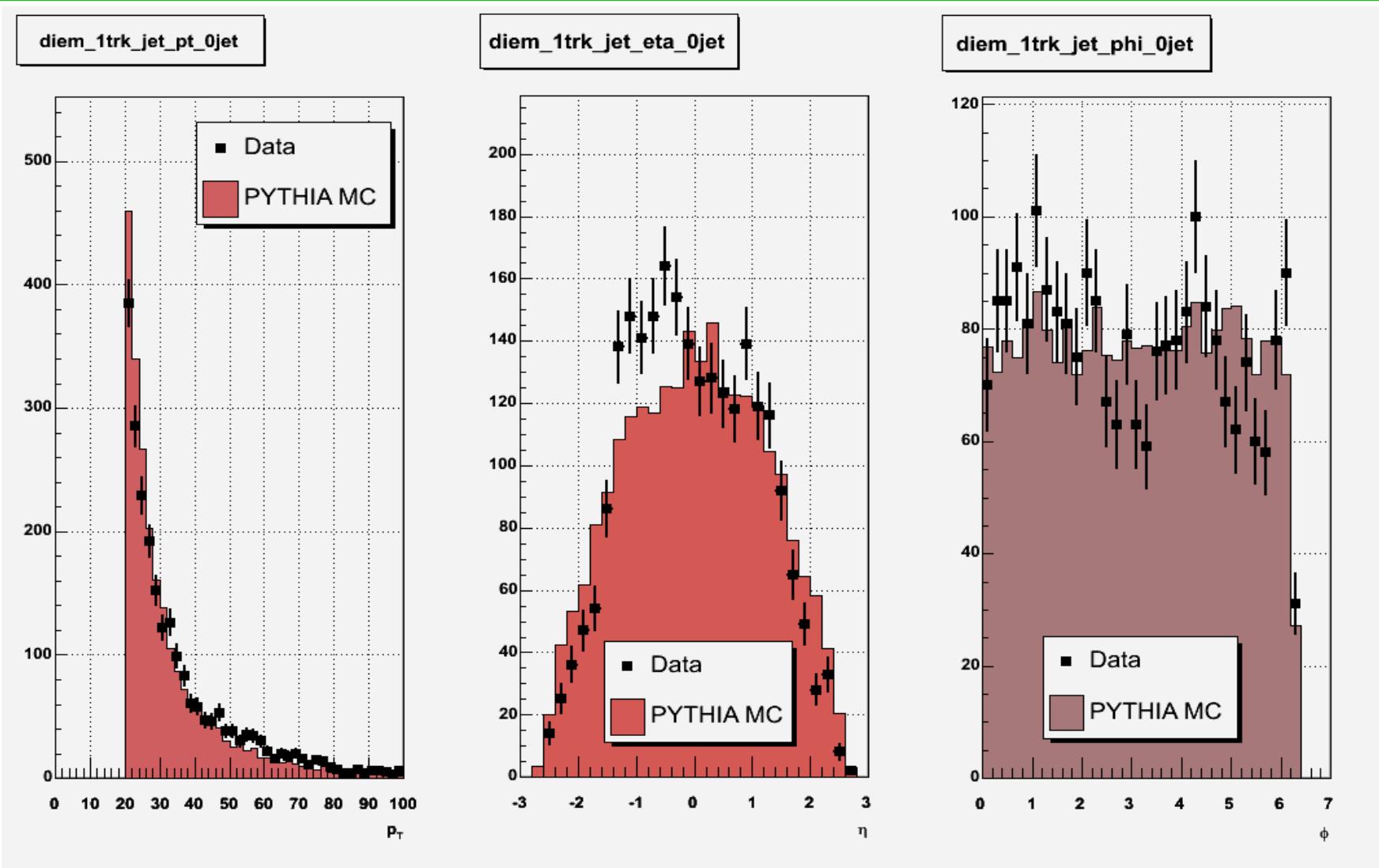


# Z(ee)+X: MC jet reco scaling factor

- Scale factor = (Jet Reco Eff in Data) / (Jet Reco Eff in MC)  
=  $1.00 * \text{Erf} ( 0.0308 * 80 * (\text{jet\_pt} - 2.75) / 69 + 0.311 )$



# Data vs MC: Jets



Marc Buehler

H(Multileptons)

11-18-04

21

---

# **Z(ee) + n Jets**

## **(n = 1 - 6)**



# Data & MC Tuning: Z(ee)+ n Jets

---

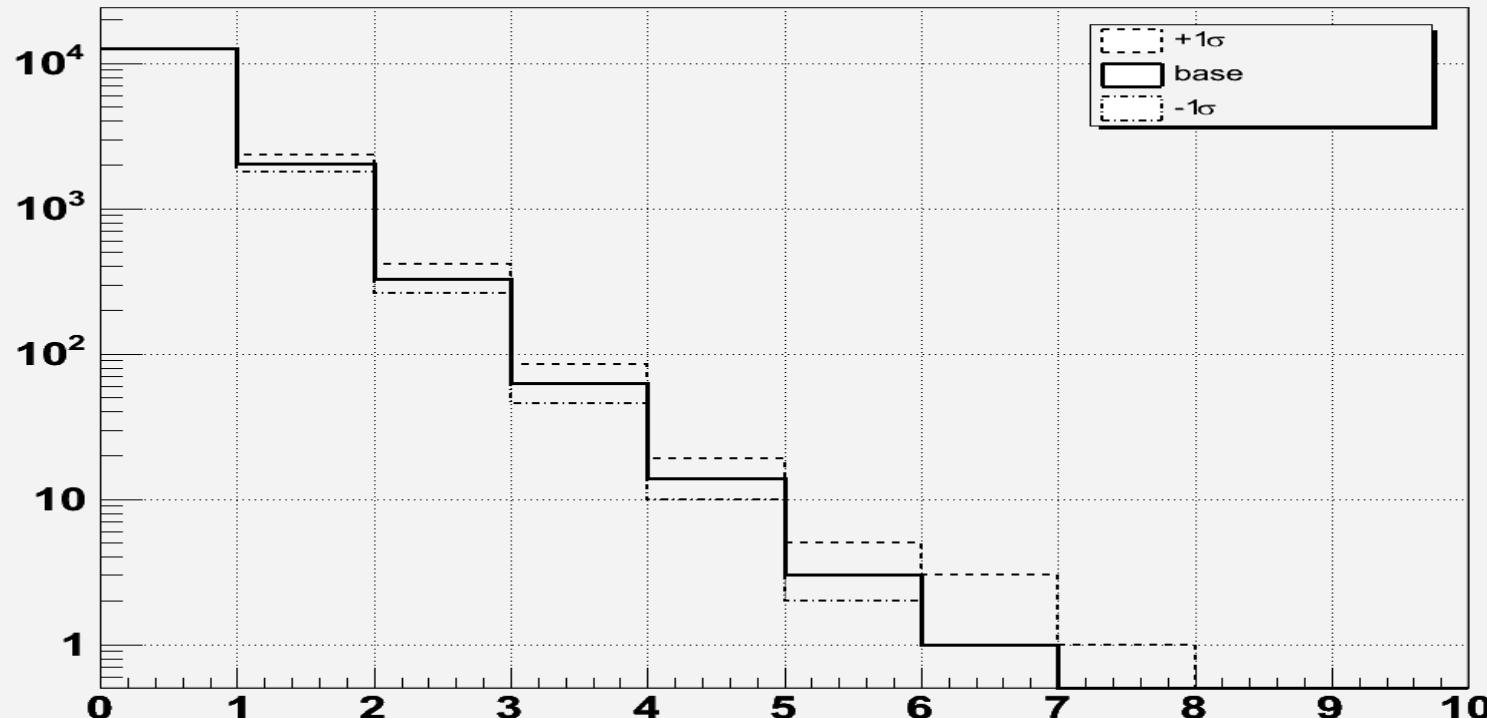
	Electrons	Jets
Data	<ul style="list-style-type: none"><li>- Correct for data EM inefficiencies</li><li>- Correct for trigger inefficiencies</li><li>- Correct for data tracking inefficiencies</li><li>- Background subtraction</li></ul>	<ul style="list-style-type: none"><li>- JES 5.1/ JES 5.3</li></ul>
MC	<ul style="list-style-type: none"><li>- Electron smearing</li><li>- Correct for MC EM inefficiencies</li><li>- Correct for MC tracking inefficiencies</li><li>- Correct for difference in Z pT between data and MC</li></ul>	<ul style="list-style-type: none"><li>- JES 5.1/ JES 5.3</li><li>- Jet smearing</li><li>- Jet reco scaling factor</li></ul>



# Jet Multiplicities: data, JES 5.1

**diem\_1trk\_jetmult**

Jet pT > 20 GeV

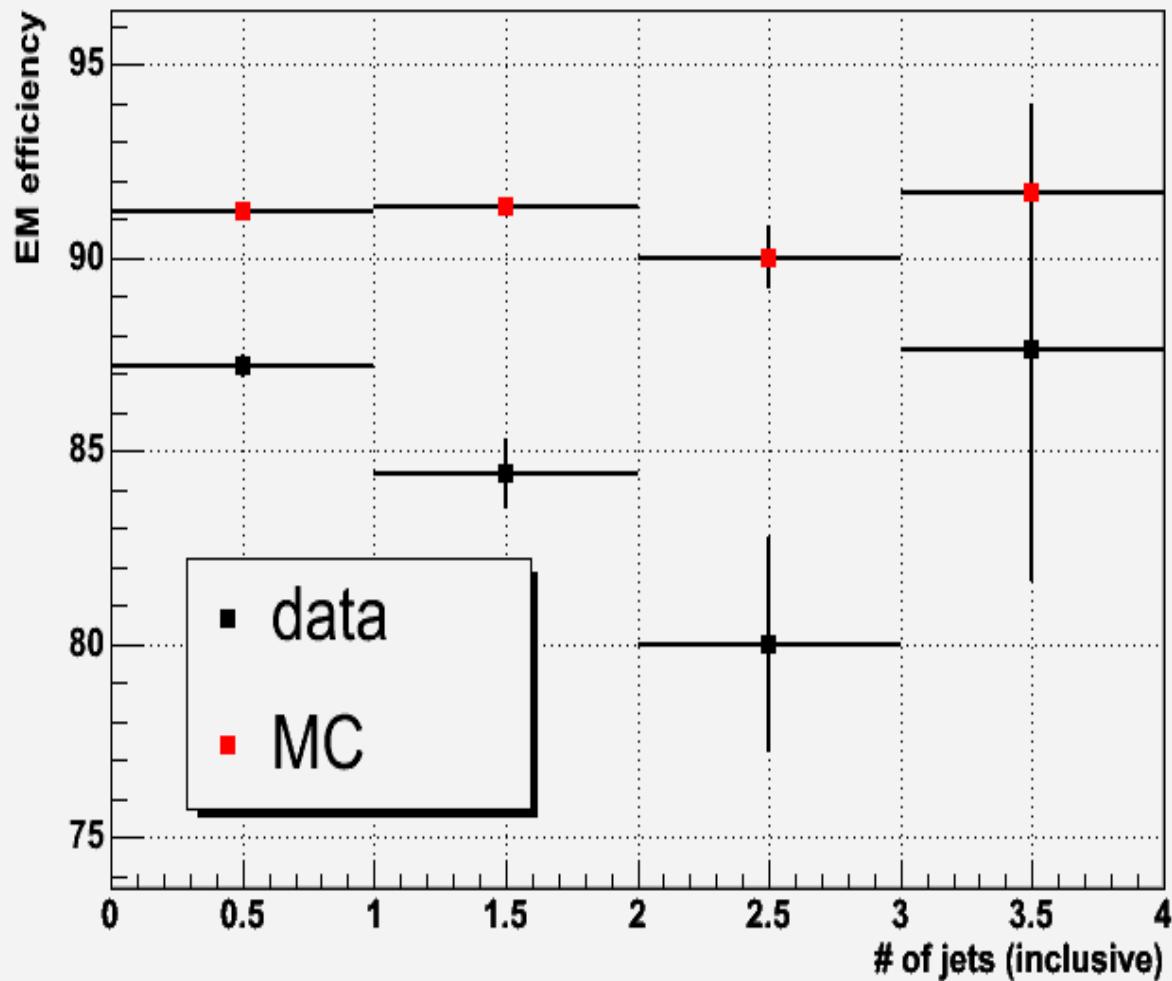


Inclusive # of jets	0	1	2	3	4	5	6	7
# events (+1 sigma)	12,718	2,350 (+16%)	414 (+27%)	85 (+35%)	19 (+36%)	5 (+67%)	3	1
# events (base value)	12,718	2,032	326	63	14	3	1	0
# events (-1 sigma)	12,718	1,804 (-11%)	264 (-19%)	46 (-27%)	10 (-29%)	2 (-33%)	1	0



# $Z(ee) + n$ Jets: Data & MC EM inefficiency corrections

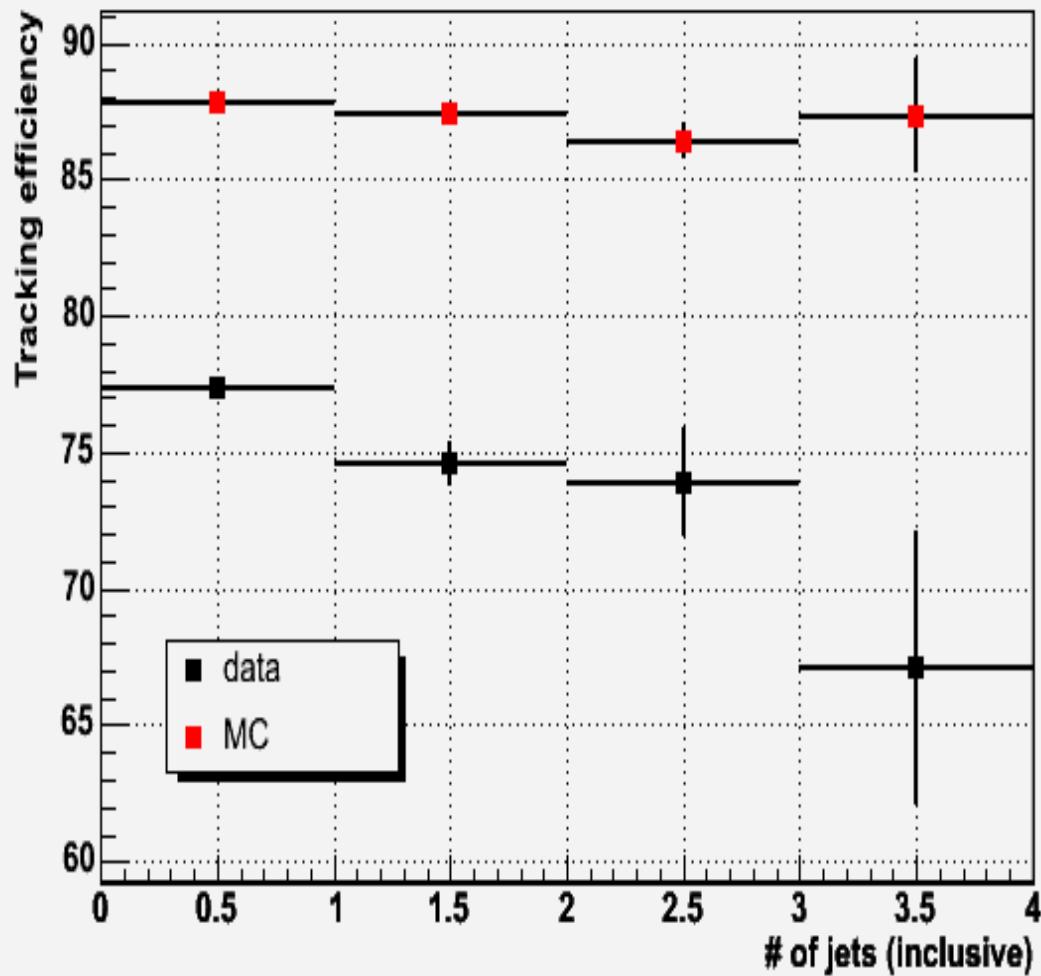
Data vs MC: EM efficiencies vs Jet Multiplicity



MC 91 %  
Data 84%

# $Z(ee) + n$ Jets: Data & MC tracking inefficiency corrections

Data vs MC: Tracking efficiencies vs Jet Multiplicity

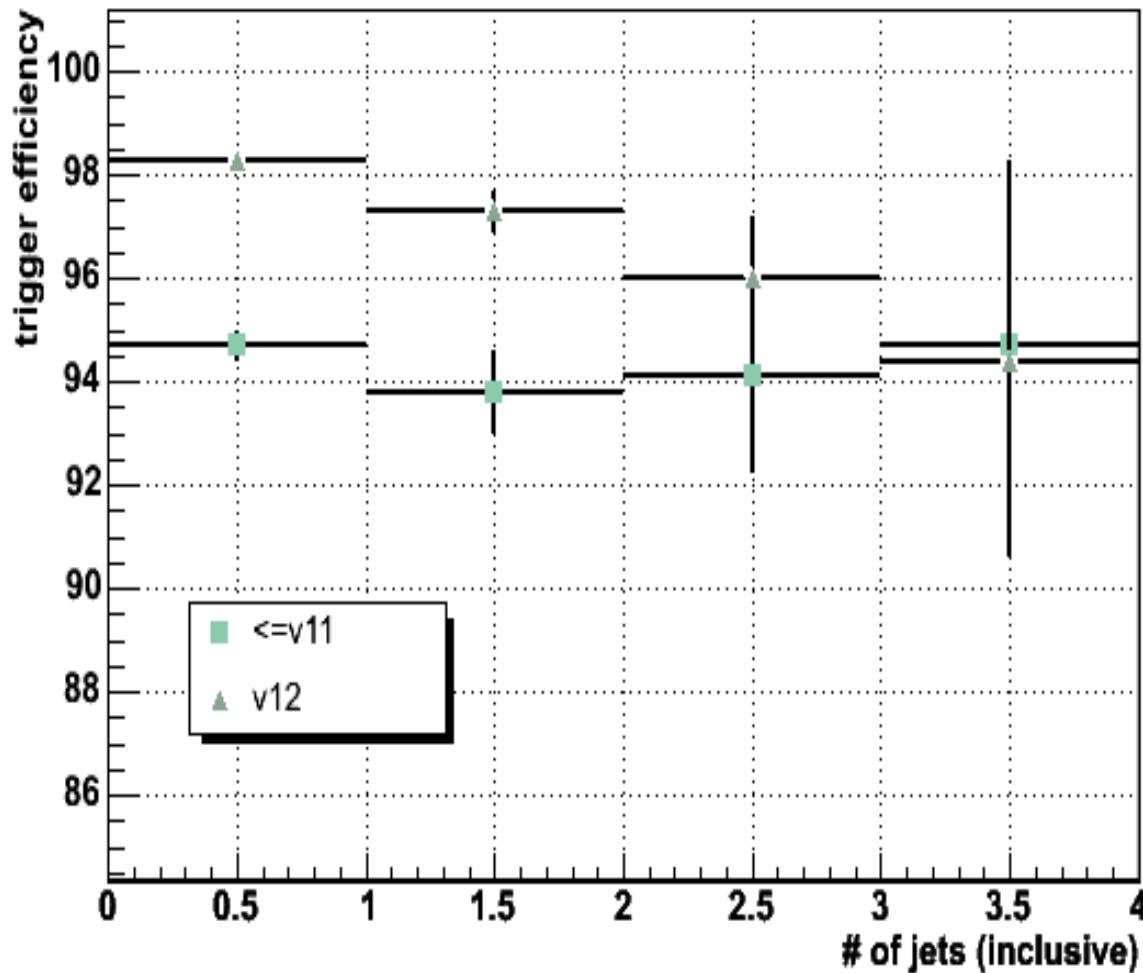


MC 87%

Data 73%

# $Z(ee) + n$ Jets: Trigger inefficiency corrections

Averaged Trigger Efficiencies vs Jet Multiplicity



pre-v12 94%

v12 96%

# todo

---

- Data vs MC
  - $Z(ee) + X$ 
    - Different background subtraction method (anti-electron cut)
    - Improve Z peak fit
    - Absolute normalization
    - Jet eta and phi features ?
  - $Z(ee) + >= n$  Jets
- Acceptance vs Jet Multiplicity
- Xsection ...

